



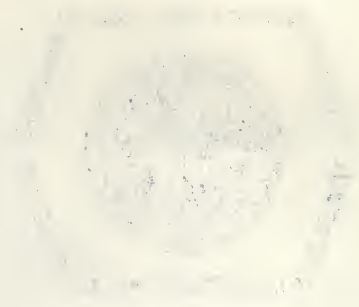
# DECUS

## PROGRAM LIBRARY

DECUS NO.	8-186
TITLE	EAE FORTRAN Patch for the PDP-8
AUTHOR	P. D. Siemens Submitted by : Wallace Clements
COMPANY	Lawrence Radiation Laboratory University of California Livermore, California
DATE	October 15, 1968
SOURCE LANGUAGE	FORTRAN

2030

1962



## EAE FORTRAN

These few paragraphs summarize the revisions made to the PDP-8 FORTRAN operating system to utilize the extended arithmetic unit option (Type 182 EAE). Four arithmetic routines were rewritten—alignment, normalize, multiply and divide. The reduction in execution time that was achieved was quite significant.

For example, an iterative-type problem that used several function subroutines (sin, cos, etc.) had been averaging 35 seconds per printout with non-EAE FORTRAN. This execution time was cut to 17 seconds with the EAE FORTRAN package. Comparative execution times of the subroutines for non-EAE FORTRAN versus EAE FORTRAN are shown in Table I.

Another improvement besides the faster execution time was gained with EAE FORTRAN. Since the multiply routine calculates a full 48-bit product and rounds instead of truncates to 24 bits, an increase in significance of the product was noted. For example, starting with 0.1 and successively multiplying by 10 for 100 times should yield 0.100000E+100. Non-EAE FORTRAN yielded 0.999973E+99, while EAE FORTRAN yielded 0.999999E+99.

These modifications work with the FORTRAN operating system of March 2, 1967. They have not been tested with any other version, but would "probably" work. No changes must be made in operating procedure or any other portion of the program, as this modification loads over the regular arithmetic subroutines.

---

This work was performed under the auspices of the U. S. Atomic Energy Commission.



TABLE I

Comparative Execution Times of EAE and Non-EAE Arithmetic Subroutines

Routine	Execution Time (usec)					
	Minimum		Average		Maximum	
	<u>EAE</u>	<u>Non-EAE</u>	<u>EAE</u>	<u>Non-EAE</u>	<u>EAE</u>	<u>Non-EAE</u>
Alignment	119	90	125	423	130	750
Normalize	41	102	51	469	61	836
Multiply	239	1116	303	1160	366	1204
Divide	128	1893	183	1936	237	1978

/EAE FORTRAN MODIFICATIONS

\*103

0103 2224 ALGN

\*141

0141 2322 MP2

0142 2320 MP4

/NORMALIZE ROUTINE FOR EAE FORTRAN

\*2200

2200	0000	NORM,	0	
2201	7300		CLA CLL	
2202	1445		TAD I L2	
2203	7450		SNA	/IS LEAST SIG. 0?
2204	5220		JMP ZCHECK	/YES, CHECK MOST SIG.
2205	7421	B1,	MQL	/LEAST SIG. TO MQ
2206	1444		TAD I H2	/MOST SIG. TO AC
2207	7411		NMI	/NORMALIZE
2210	3444		DCA I H2	/DEPOSIT INTO 2ND ARG.
2211	7501		MQA	
2212	3445		DCA I L2	
2213	7641		SCA CLA	/GET STEP COUNTER
2214	7041		CIA	/NEGATE
2215	1443		TAD I X2	/ADD EXPONENT
2216	3443	B2,	DCA I X2	
2217	5600		JMP I NORM	/EXIT
2220	1444	ZCHECK	TAD I H2	
2221	7640		SZA CLA	/MOST SIG. 0?
2222	5205		JMP B1	
2223	5216		JMP B2	/YES, 0 TO EXPONENT
/ALIGNMENT ROUTINE FOR EAE FORTRAN				
2224	0000	ALGN,	0	
2225	7300		CLA CLL	
2226	3303		DCA ID	
2227	1440		TAD I X1	
2230	7041		CIA	
2231	1443		TAD I X2	
2232	7450		SNA	/EXPONENTS EQUAL?
2233	5275		JMP DONE	/YES
2234	7510		SPA	/X2 GREATER
2235	5246		JMP TWO	





2236	7041		CIA	
2237	7040		CMA	/X2-X1-1
2240	3271		DCA SHFT	/NUMBER OF SHIFTS
2241	7340		CLA CLL CMA	
2242	3303		DCA ID	
2243	1041		TAD H1	
2244	3304		DCA PNT	/SET POINTER
2245	5254		JMP BOTH	
2246	7040	TWO	CMA	/X1-X2-1
2247	3271		DCA SHFT	/NUMBER OF SHIFTS
2250	1044		TAD H2	
2251	3304		DCA PNT	/SET POINTER
2252	1440		TAD I X1	
2253	3443		DCA I X2	/X2=X1
2254	1271	BOTH,	TAD SHFT	
2255	1306		TAD M24B	
2256	7700		SMA CLA	/TOO MANY SHIFTS?
2257	5300		JMP NOGO	/YES
2260	7101		CLL IAC	
2261	1304		TAD PNT	
2262	3305		DCA PNT+1	
2263	1705		TAD I PNT+1	
2264	7421		MLQ	/LEAST SIG. TO MQ
2265	1704		TAD I PNT	/MOST SIG. TO AC
2266	7510		SPA	/POSITIVE?
2267	7020		CML	/NO, SET MINUS SIGN
2270	7415		ASR	/SHIFT RIGHT
2271	0000	SHFT,	0	
2272	3704		DCA I PNT	
2273	7501		MQA	
2274	3705		DCA I PNT+1	
2275	7300	DONE,	CLA CLL	
2276	2224		ISZ ALGN	
2277	5624		JMP I ALGN	/EXIT
2300	2303	NOGO,	ISZ ID	
2301	4561		JMS I SWP	/MAKE ARG2 LARGEST
2302	5624		JMP I ALGN	/EXIT
2303	0000	ID,	0	
2304	0000	PNT,	0	
2305	0000		0	
2306	7750	M24B,	-30	





/DIVIDE ROUTINE FOR EAE FORTRAN

/CALLING ROUTINE MODIFICATIONS

\*2051

2051 7000 NOP

\*2063

2063 1005 TAD SIGN  
2064 7710 SPA CLA

\*2153

2153 1005 TAD SIGN  
2154 7700 SMA CLA  
2155 5500 JMP I INT I  
2156 1444 TAD I H2  
2157 7041 CIA  
2160 3444 DCA I H2  
2161 5500 JMP I INT I

\*2400

2400	0000	DDVD,	0	
2401	4672		JMS I SN	/CHECK SIGNS
2402	3006		DCA DIVID	/CLEAR FLAG
2403	1442		TAD I L1	
2404	7104		CLL RAL	
2405	3224		DCA DDVD3	/SHIFT DIVISOR LEFT
2406	1441		TAD I H1	
2407	7004		RAL	
2410	3245		DCA DDVD4	
2411	1245		TAD DDVD4	
2412	3217		DCA DDVD2	
2413	1445		TAD I L2	
2414	7421		MQL	/LEAST SIG. TO MQ
2415	1444		TAD I H2	/MOST SIG. TO AC
2416	7407		DV1	/(MS2+LS2*2**-12)/MS1
2417	0000	DDVD2	0	
2420	3217		DCA DDVD2	/REMAINDER
2421	7501		MQA	
2422	3444		DCA I H2	/QUOTIENT
2423	7405		MUY	
2424	0000	DDVD3	0	/QUO.*LS1*2**-12
2425	7141		CLL CMA IAC	/NEGATE PRODUCT
2426	1217		TAD DDVD2	
2427	7450		SNA	
2430	5573		JMP I DV5 I	/HI PROD.=REM. (L=1)
2431	7420		SNL	
2432	5250		JMP DDVD6	/HI PROD.>REM.



2433	3224		DCA DDVD3	/REM.>HI PROD.
2434	7040		CMA	
2435	3006		DCA DIVID	/SET FLAG
2436	7501		MQA	/SUBTRACT LOW ORDER PROD.
2437	7141		CLL CIA	/FROM DDVD3+0*2**-12
2440	7421		MQL	
2441	7420		SNL	
2442	7040		CMA	/DDVD3-1
2443	1224		TAD DDVD3	
2444	7407		DVI	/(REM.-QUO.*LS1*2**-12)/MS1
2445	0000	DDVD4,	0	
2446	5647		JMP I .+1	
2447	2701		AAADIV	
2450	7041	DDVD6,	CIA	
2451	3217		DCA DDVD2	/HI PROD.>REM.
2452	1245		TAD DDVD4	
2453	7141		CLL CIA	
2454	1217		TAD DDVD2	
2455	7420		SNL	
2456	5263		JMP .+5	
2457	3217		DCA DDVD2	
2460	7040		CMA	
2461	1444		TAD I H2	
2462	3444		DCA I H2	
2463	7200		CLA	
2464	1217		TAD DDVD2	
2465	7440		SZA	
2466	5244		JMP DDVD4-1	
2467	5670		JMP I DV5M1	
2470	2704	DV5M1,	DDVD5-1	
2471	5600	RDV,	JMP I DDVD	
2472	2664	SN,	SGN	
2473	2705	DV5I,	DDVD5	





\*2307

2307	7110	DDVD7,	CLL RAR	/SHIFT QUO. RIGHT
2310	3444		DCA I H2	
2311	1445		TAD I L2	
2312	7010		RAR	
2313	3445		DCA I L2	
2314	2443		ISZ I X2	
2315	5717		JMP I RET1	
2316	5717		JMP I RET1	
2317	2471	RET1,	RDB	





/MULTIPLY ROUTINE FOR EAE FORTRAN

\*2600

2600	0000	DMUL,	0	
2601	4264		JMS SGN	/CHECK SIGNS
2602	1064		TAD M2	
2603	3361		DCA CNT1	
2604	1254		TAD BSTKAD	
2605	3017		DCA TEMC	/PRODUCT TABLE POINTER
2606	7040		CMA	
2607	1041		TAD H1	
2610	3015		DCA TEMA	/ARG1 POINTER
2611	1064	A2LO,	TAD M2	
2612	3362		DCA CNT2	
2613	7040		CMA	
2614	1044		TAD H2	
2615	3016		DCA TEMA	/ARG2 POINTER
2616	1415		TAD I TEMA	/GET ARG1
2617	3222		DCA MUL	
2620	1416	A3LO,	TAD I TEMA	/GET ARG2
2621	7425		MQL MUY	
2622	0000	MUL,	0	
2623	3417		DCA I TEMC	/STORE IN PRODUCT TABLE
2624	7501		MQA	
2625	3417		DCA I TEMC	
2626	2362		ISZ CNT2	
2627	5220		JMP A3LO	
2630	2361		ISZ CNT1	
2631	5211		JMP A2LO	
2632	1263		TAD A	/ADD PRODUCTS FROM TABLE
2633	1262		TAD B	
2634	1260		TAD D	
2635	7004		RAL	/CARRY
2636	7630		SZL CLA	
2637	7001		IAC	/ROUND
2640	7100		CLL	
2641	1261		TAD C	
2642	1257		TAD E	
2643	1256		TAD F	
2644	3445		DCA I L2	
2645	7004		RAL	
2646	1255		TAD G	
2647	3444		DCA I H2	
2650	1005		TAD SIGN	
2651	7710		SPA CLA	
2652	4537		JMS I NEG	
2653	5600		JMP I DMUL	



2654	2654	BSTKAD,	G-1
2655	0000	G,	0
2656	0000	F,	0
2657	0000	E,	0
2660	0000	D,	0
2661	0000	C,	0
2662	0000	B,	0
2663	0000	A,	0
2664	0000	SGN,	0
2665	1444		TAD I H2
2666	0300		AND MASK
2667	1441		TAD I H1
2670	3005		DCA SIGN
2671	1444		TAD I H2
2672	7710		SPA CLA
2673	4537		JMS I NEG
2674	1441		TAD I H1
2675	7710		SPA CLA
2676	4536		JMS I NEG1
2677	5664		JMP I SGN
2700	4000	MASK,	4000

/SIGN OF PROD. OR QUO.

\*2761

2761	0000	CNT1,	0
2762	0000	CNT2,	0

/MULTIPLY FOR XTRA-SPECIAL INDEX CALCULATOR

\*2320

2320	0000	MP4,	0
2321	7425		ML MUY
2322	0000	MP2,	0
2323	5720		JMP I MP4





/ DEFINITIONS FOR EAE FORTRAN

X1=40  
H1=41  
L1=42  
X2=43  
H2=44  
L2=45  
SIGN=5  
TEMA=15  
TEMB=16  
TEMC=17  
M2=64  
SWP=161  
INTI=100  
DIVID=6  
NEG=137  
NEG1=136  
DVI=7407  
NMI=7411  
SHL-7413  
ASR=7415  
MQL=7421  
MUY=7405  
MQA=7501  
SCA=7441





A	2663
AAADIV	2701
ALGN	2224
ASR	7415
A2LO	2610
A3LO	2616
B	2662
BOTH	2254
BSTKAD	2654
B1	2205
B2	2216
C	2661
CNT1	2652
CNT2	2653
D	2660
DDVD	2400
DDVD2	2417
DDVD3	2424
DDVD4	2445
DDVD5	2705
DDVD6	2450
DDVD7	2307
DIVID	0006
DMUL	2600
DONE	2275
DVI	7407
DV5I	2473
DV5M1	2470
DV7I	2716
E	2657
F	2656
G	2655
H1	0041
H2	0044
ID	2303
INTI	0100
L1	0042
L2	0045
MASK	2700
MP2	2322
MP4	2320
MQA	7501
MQL	7421
MUL	2620
MUY	7405
M2	0064
M24B	2306

NEG	0137
NEG1	0136
NMI	7411
NOGO	2300
NORM	2200
PNT	2304
RDV	2471
RET	2715
RET1	2317
SCA	7441
SGN	2664
SHFT	2271
SHL	7413
SIGN	0005
SN	2472
SWP	0161
TEMA	0015
TEMB	0016
TEMC	0017
TWO	2246
X1	0040
X2	0043
ZCHECK	2220

